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ABSTRACT

The current philosophical position of the project is reviewed and a variety of issues relevant to educational evaluation and achievement monitoring are enumerated. Various past attempts to model the variables of school learning are reviewed and those adopted for the Comprehensive Achievement Monitoring model are discussed. The student variables include verbal, reasoning, spatial, perceptual, and memory aptitudes in the general domain; and prior achievement, motivation, anxiety, sociological characteristics, and rate of learning in the task specific domain. Instructional variables are teacher, treatment characteristics, and time. Two important features of the program are (1) the emphasis placed on defining course objectives in a detailed manner, and (2) monitoring student achievement on these objectives longitudinally. The report also discusses the focus, resources, collection, organization, and analysis of data that will be used to evaluate the project. Finally, the favorable teacher and student reactions to the monitoring are discussed. (AE)

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Project Comprehensive
Achievement
Monitoring

Technical Memorandum No. AR-2 December 1968

SECOND ANNUAL REPORT

by

D. W. Allen, The University of Massachusetts
and
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The research and development reported herein was performed pursuant to a grant from the Charles F. Kettering Foundation to the Principal Investigator, Dr. Dwight W. Allen, Dean, School of Education, The University of Massachusetts. The Project CAM staff includes D. Evans, W. Gorth, and P. Pinsky.

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SECOND ANNUAL REPORT

Submitted to the Charles F. Kettering Foundation

Title: THE DEVELOPMENT OF RANDOMIZED ACHIEVEMENT MONITORING

Submitted by: The University of Massachusetts

Initiated by: Dwight W. Allen
Dean, School of Education

Date: 15 December 1968

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Abstract

The Second Annual Report to the Charles F. Kettering Foundation on the progress to develop a comprehensive randomized monitoring is designed to outline the experience and flexibility that the project has gained from its work. The report includes an overview of the current philosophical position of the project. A variety of issues relevant to educational evaluation and achievement monitoring are enumerated. The report closes with a discussion of the teacher and student reactions to the monitoring and the priorities for the future work of the staff.

Overview

Need for Achievement Monitoring

There has rarely been a time in the history of American education when there has been such an intense concern for educational evaluation. Many books discuss evaluation in detail, including a revision of Educational Measurement and the next yearbook by the NSSE. The pages of magazines such as Educational Technology, Educational and Psychological Measurement, and Journal of Educational Measurement, are bulging with articles delimiting the need for evaluation in school courses. The Association for Supervision and Curriculum Development has devoted an entire volume of its recent yearly publication to evaluation as feedback and guide (1957). Further, a very important article by Cronbach (1963) entitled "Evaluation for Course Improvement" is becoming more widely read and quoted. Much of the recent American Educational Research Association monograph, editing by Stake (1967) entitled "Curriculum Evaluation" is concerned with specifying in more detail issues raised by Cronbach.

There seems to be no subject or grade level in public schools which can reasonably ignore evaluation. It is important for every school course to consider more seriously its objectives and how well these objectives are being reached. Our project focuses on an important aspect of evaluation, achievement monitoring. It has considered a variety of subjects and grade levels as shown in Table AR-2.1.

Comprehensive Achievement Monitoring

One of the primary objections the current authors raise to the earlier methodology of evaluation is its narrowness. Many of the early evaluations or those of Title I and Title III projects consists of unsystematic interviews with teachers and students and a posttest of student achievement using standardized batteries of tests. These techniques make it difficult to pinpoint the strengths and weaknesses of a course if only one or two measures

Table AR-2.1 Comprehensive Achievement Monitoring: Subject and Grade Level

Subject	Grade level					
	Pre-high school	9	10	11	12	Post-high school
Science	P	C	C	P		
Mathematics	P	C	C	C	C	C
English			C			
History	P		C	C	C	
Vocational						C

Note.--C = operational and P = planned soon for Comprehensive Achievement Monitoring.

are taken or if the measures focus on only some general and nebulous quantity called achievement.

Our project has sought to develop a comprehensive design for the monitoring of student achievement in high school courses. The achievement monitoring design developed by the project is comprehensive in two primary dimensions. It is comprehensive in terms of a multivariable model of school achievement and the longitudinal measurement of the objectives of a course.

A Model of School Achievement

Several recent efforts have attempted to model school learning. Carroll (1967) has described a semi-quantitative model which was used by Bloom (in press) to describe rates of student learning. Carroll provides a basis to decide which variables to measure in an attempt to adequately describe school learning.

The project accepts the very important notion that a model of school learning or more specifically a model of school achievement is necessary to focus an evaluation design on the relevant variables. However, the design suggested by Carroll seems to ignore several variables or interactions of variables which seem to be particularly relevant for school achievement.

First, Carroll indicates that a measure of perseverance is an important contributor to the model of school achievement. The notion of perseverance seems to lack adequate ties with earlier and better founded notions of motivation which can themselves be used as variables in a model of school achievement. Our project prefers to use the better documented notions of achievement motive (Alschuler).

Second, Alschuler explains that although a student may be highly motivated to perform a particular task, his anxiety at entering task situation may prevent or interfere with several of the skills which are necessary in performing the task. The effect of anxiety on complex learning has been investigated by Spielberger (1966) and it seems relevant to the model of school achievement. This is particularly evident in schools where students are under very high parental or peer pressure to succeed academically.

Third, sociological variables appear important. Coleman (1966) has demonstrated a correlation of certain social and family variables with school achievement. They seem important particularly in public schools which enroll students from a broad range of family backgrounds to include a variety of measures of student family community and peer influences on the student.

Fourth are the variables of rate of learning and initial achievement (Yeager & Lindvall, 1967). In the school environment the rate of learning and initial achievement seem to correlate very highly with achievement output. It may also be relevant to follow the variation in rate with the other student variables already mentioned (Tucker, 1960).

Although Carroll mentions both instructional and student variables, he does not explore the implications of their interactions as clearly as Cronbach (1967) has. It is very important to understand that the interactions of instructional treatment and student variables may drastically change the interpretation of results for student achievement and must be considered explicitly in a model of school achievement.

The constituents of a model of student achievement which the project intends to utilize are outlined in school achievement in Table AR-2.2.

A further consideration in evaluation of school achievement is suggested by Rothkopf (1965). He describes how the evaluation may interact with student achievement. Some forms of evaluation may increase students' learning. Rothkopf has shown that certain kinds of tests administered during learning, from written materials, increases achievement. The project, in an experiment with videotaped lectures (TM-4),* has shown a similar effect on students' achievement with different patterns of comprehensive pretesting.

Thus, some experimental evidence exists that even the form of the evaluation of achievement should be entered into the model of school achievement. Experimentation in high school courses by

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*TM indicates a project Technical Memorandum.

Table AR-2.2 Comprehensive Achievement Monitoring: The Model of School Achievement

Domain	Student variable	Instructional variables		
		Teacher	Treatment characteristics	Time
General	Aptitude:			
	Verbal	--	--	--
	Reasoning	--	--	--
	Spatial	--	--	--
	Perceptual	--	--	--
	Memory	--	--	--
Task specific	Prior achievement	--	--	--
	Motivation	--	--	--
	Anxiety	--	--	--
	Sociological characteristics	--	--	--
	Rate of learning			

the project (TM-16) suggests that these effects are very small and therefore are not included in the model.

Objectives and Time: Important Treatment Characteristics

It is important to use a model of school achievement to suggest variables which are relevant for an achievement monitoring program. Two important features of the comprehensive achievement monitoring are (a) the emphasis on defining the objectives of the course in a detailed fashion, and (b) monitoring the students' achievement on these objectives longitudinally.

It has only been in recent years that teachers have begun to define their objectives in behavioral terms. Authors like Mager (1962) have written persuasively in favor of specifying instructional objectives in terms of observable student behavior. In the case of comprehensive achievement monitoring, the behavior desired is performance on achievement questions. The teacher is expected to define the objectives of his course in terms of observable student behavior by composing questions which measure acceptable levels of student performance for the objectives he set for his course.

A second unique aspect of the comprehensive achievement monitoring is the longitudinal consideration of students achievement on each of the objectives of a course. A comparison of the estimates of achievement available by the usual classroom testing (Table AR-2.3) and comprehensive achievement monitoring (Table AR-2.4) highlights the characteristics of longitudinal monitoring. In usual classroom testing a test of achievement is given immediately after an objective or set of objectives has been presented by the teacher. The test usually includes items which measure only the objectives taught since the last testing. Therefore, as Table AR-2.3 shows, the teacher has available only estimates of student achievement on the objectives he has just completed teaching.

Table AR-2.3 Usual Classroom Testing: Achievement for a Specified Group of Students for Objectives by Time

Objective	Time					
	1	2	3	4	...	T
1	U					
2		U				
3			U			
4				U		
...					U	
O						U

Note.--U = estimate of achievement available by usual classroom testing.

Table AR-2.4 Comprehensive Achievement Monitoring: Achievement for a Specified Group of Students for Objectives by Time

Objective	Time					
	1	2	3	4	...	T
1	C	C	C	C	C	C
2	C	C	C	C	C	C
3	C	C	C	C	C	C
4	C	C	C	C	C	C
...	C	C	C	C	C	C
O	C	C	C	C	C	C

Note.--C = estimate of achievement available by Comprehensive Achievement Testing.

Contrasted with the usual testing is comprehensive achievement monitoring where estimates of student achievement on each of the objectives are available throughout the time of monitoring. This type of testing allows teachers to make statements about a student's rate of learning, achievement immediately after instruction, and rate of forgetting. For example, consider achievement monitored at time 4. If time 4 is immediately after objective 4 has been taught, the estimate of student achievement for objective 4 is an immediate posttreatment achievement. At time 4 the estimates of achievement on objectives 1, 2, and 3 represent achievement a given time after the teaching of these objectives and measure forgetting. Further, the achievement on objectives to be taught next in the course are also measured by the comprehensive achievement monitoring. Therefore, preinstructional treatment estimates of achievement are available to the teacher. The importance of the availability of these estimates on all of the objectives for a course at each time will be discussed below.

A Design for Comprehensive Achievement Monitoring

Although the model of student achievement suggests the variables which are important for the consideration of achievement, a design must be developed which operationalizes the measurement of these variables in the school.

The Matrix of a Design

A variety of authors have suggested designs for educational evaluation. Most of these designs are much more concerned with the operational needs of an evaluation system rather than the model from which the evaluation is developed. We will add the notion of a model of school achievement to the operational considerations discussed by several designs for educational evaluation (Stufflebeam, 1968).

The matrix of a design for comprehensive achievement monitoring is displayed in Table AR-2.5. The domains of the monitoring may be considered to include the context, input, process and product of learning. We will consider context of the monitoring to include measures of the students who enter a program of study concerned with their general level and abilities. The input will be considered the achievement and knowledge which they bring to the learning situation. The process will be the mental processes by which they learn the materials of the course and the product will be the final behavior in the course. A variety of issues in the design of the monitoring program are outlined in the left-hand column of the table. Each of the issues in the design will be considered below.

Model of the Parameters

Student Variables

During the first year of the project student variables were not measured for all the variables included in the current model of student achievement. During the first year a pretest

Table AR-2.5 The Matrix of a Design for Comprehensive Achievement Monitoring

Issues in design	Domains of the monitoring			
	Context	Input	Process	Product
Model of the parameters	C	C	P	C
Focus of the evaluation	C	C	P	C
Resources for the evaluation	C	C	P	C
Collection of the data	C	C	P	C
Organization of the data	C	C	P	C
Analysis of the data	C	C	P	C
Report of the analysis	C	C	P	C

Note.--C = operational and P = planned soon for Comprehensive Achievement Monitoring.

or input level of achievement for the course monitored by the project was the major pretreatment measure. This year, following the model, measures of student aptitudes, achievement motivation, anxiety, demographic information, and attitude toward mathematics were measured by a student pretest and questionnaire (TM-18).

Instructional Variables

The instructional variables recorded include the complete list of the objectives for each course specified in behavioral terms. Several characteristics of the teachers collected by a questionnaire (TM-18) and measures of the time taken by the students to complete certain objectives of the course.

Focus of the Evaluation

The level of decision making. The monitoring of achievement can be of interest to the student enrolled in the course, to the teacher teaching the course, to the department in which the course is taught, to the school, to the school district, to the state and even to the national level. Each of these levels would be extremely interesting to consider by the evaluation design discussed here, but the primary interest of the project has been at the student, teacher and departmental levels. The project may become involved with school and school district concerns with achievement monitoring but these levels will be pursued to better provide information for students, teachers and department. At each level of evaluation a variety of decision-situations occur.

The decision-situation. Each decision-situation includes a question of the setting (the course in which decisions are to be made), the alternatives (choices available), the variables (parameters of the choice), and the criteria (rules to make the choice based upon information collected). A variety of decision-situations have been identified by the project. The major decision-situations are those of assigning students to different instructional treatments (TM-2; Silberman, 1968), of encouraging students in their studies, and providing information to teachers and departments for improving their courses. (see Table AR-2.6).

Table AR-2.6 Focus of the Evaluation: Level and Decision Situation

Level	Decision situation			
	Setting	Alternatives	Variables	Criteria
Student	C	C	C	C
Teacher	C	C	C	C
Department	C	C	C	C
School	P	P	P	P
School district	P	P	P	P
State				
National				

Note.--C = operational and P = planned soon for Comprehensive Achievement Monitoring.

Resources for the Evaluation

Staff. The project has considered a variety of patterns of staffing for the monitoring of achievement. The job of specifying a curriculum in behavioral terms and writing questions to measure these objectives is substantial. The best strategy seems to be for a team of teachers to work together or to develop an objectives item bank. The project has utilized a single teacher for a course at a school, a team of teachers and an entire department of a school involved in the monitoring program.

Facilities. A large range exists in the types of facilities available to teachers working with comprehensive achievement monitoring. Most schools have teaching aid available to assist teachers in clerical work and administering monitors. One school has a testing room, where students could be scheduled for a monitor. The teachers working closely with the project have had the answer sheets from their monitoring scored by optical scanners at Stanford University. Several school districts in the project now have optical scanners of their own and are considering utilizing a school base facility. During the first year of operation all schools sent their monitoring data to Stanford University where they were processed and analyzed on the Stanford computer. Several schools are using a local data processing system for their projects. (see Table AR-2.7).

Collection of the Data

Source of data. The major source of data remains the student responses to achievement test questionsl The model of school achievement has suggested that other measures of each student be taken. Also, information about the teachers and the schools are being collected this year. All types of information, in addition to the student responses to achievement items, are new sources of data this year.

Objectives and time. At the heart of the project are the variables of objectives and time. Course objectives have been all specified in behavioral terms. The specificity of the

Table AR-2.7 Resources for the Evaluation: Staff and Facilities

Staff	Facilities			
	Teaching aids	Testing room	Optical scanner	Computer
One teacher	C		C	C
Team of teachers	C		C	C
Department in school	C	C	C	C
Faculty of school		P	P	P
School district			P	P
Private agency				
State officials				
National officials				

Note.--C = operational and P = planned soon for Comprehensive Achievement Monitoring.

objectives does vary. In some cases the objectives are written for individual tasks. In other cases a lesson which might take one day to present is the unit of specificity. Other levels include a package or unit which includes several objectives which are interrelated and are presented to students within a period of about a week. Some objectives for a course or a school program have been discussed. The specificity of objectives varies from one school to another. The project is considering the most appropriate level of specificity for different types of achievement monitoring.

A taxonomy of educational objectives has been suggested by Bloom (1956). This taxonomy has been considered as a way of categorizing the objectives which have been written for the project. One school has been instructed to classify its mathematics objectives both in terms of a level of cognitive difficulty and in terms of mathematical content (TM-2). A variety of other schemes may be tried. The important consideration will be to provide an operational technique for categorizing objectives into meaningful headings in order to devise better ways of analyzing results. A booklet of the objectives written for the project will be developed so that teachers preparing courses in subjects already monitored will be able to compare their suggested objectives with an already written set of objectives. This may reduce one of the bottlenecks for instituting comprehensive achievement monitoring.

The other major dimension, time, is specified by the interval between monitoring of student achievement. The project has tried a variety of time intervals. Table AR-2.8 displays the time intervals used as well as the specificity of performance objectives. The time interval is very closely related to the logistics monitoring and the need for current up-to-date information. The balance between these two factors and that of time has been explored and several alternatives may be suggested.

Sampling of students and items. Important dimensions of the project are objectives and time, but the technique used to obtain estimates of achievement on each objective at each time is

Table AR-2.8 Collection of Data: Performance Objectives and Time--the Major Dimensions

Specificity of performance objectives	Time interval between monitorings					
	Day	Week	Two weeks	Month	Semester	Year
Individual task	P	C	C			
Lesson	P	C	C			
Package or units	C	C	C	C		
Course		C	C	P	P	P
School program				P	P	P

Note.--C = operational and P = planned soon for Comprehensive Achievement Monitoring.

the technique of sampling. The students and items form two pools from which samples may be drawn to obtain estimates of achievement. The technique of sampling items and students has been suggested by Cronbach (1963) and the theory of the sampling has been detailed by Lord and Novick (1968). A large variety of different techniques have been utilized by the project in its past and current monitoring programs. Table AR-2.9 displays the type samples possible from the pool of items and students. A variety of prescriptions have been developed to aid both research questions, course evaluation and student feedback to make them as effective as possible.

With the development of such a large number of items the project has considered developing an item bank. An item bank would provide a ready access of items to measure specific objectives for teachers developing comprehensive achievement monitoring programs. The items could eventually be standardized in terms of the students who take the item monitors based upon their performance as well as other variables in the model. Thus an item may have a norm related to students with certain cognitive abilities from certain types of socioeconomic backgrounds who have taken the item at particular times during the school year or before or after the item has been taught.

Instruments. The collection of data on certain variables for the model of school achievement has been accomplished at the beginning of the year with an extensive set of pretests (TM-18). During the school year the achievement monitors administered by the program have been chosen to be parallel in content. The additional important restriction has been placed on the selection of items for monitors during the second year of the project, i.e., that the monitors be somewhat equivalent in difficulty. The technique of constructing individual tests, which are equal in difficulty, allows comparisons of total test scores from one time period to another for individual students (TM-15) and is a unique feature of the comprehensive monitoring program.

Schedules. The logistics of achievement monitoring can become quite complicated. The basic design of the comprehensive monitoring program in general necessitates the administration of all of the items

Table AR-2.9 Collection of Data: Sampling of Students and Items, for Each Performance Objective at Each Time

Sample number	Item sample (n_i) of pool (N) for each objective	Student sample of pool					
		1	2	3	4	5	6
1	One sample ($n_i < N$)	C	C	C	C	C	C
2	Equal samples, nonexhaustive ($n_i = n_j$; $\Sigma n_i < N$)		C		C		
3	Unequal samples, nonexhaustive ($n_i \neq n_j$; $\Sigma n_i < N$)		C		C		
4	Equal samples, exhaustive ($n_i = n_j$; $\Sigma n_i = N$)		C		C		
5	Unequal samples, exhaustive ($n_i \neq n_j$; $\Sigma n_i = N$)		C		C		
6	Total pool (N)	C	C		C		

Note.--Criteria for sampling items or students may be a function of time during the year. C = operational and P = planned soon for Comprehensive Achievement Monitoring.

selected for the initial pool to at least some of the students every monitoring period. Therefore, all of the parallel monitor forms constructed at the beginning of the year are administered each monitoring period. A variety of techniques has been investigated for simplifying the presentation of monitoring schedules and to facilitate teacher administration of the monitors. A viable set of suggestions has been developed for both teacher and educational research monitoring.

Organization of the Data

Monitor generation. Because of the large number of test questions used in the achievement monitoring program, various techniques were developed to generate the monitor forms needed. These techniques are outlined in the left-hand column of Table AR-2.10. The project has utilized the first three techniques (TM-14). Suggestions for tests generated by algorithms, by computer, or presented by computer, linear or branched, are possibilities for future applications in comprehensive achievement monitoring (Harmand, Helm, & Loye, 1968). Although these would be interesting and possible profitable directions for the monitoring procedure, they are much more expensive and require more computer hardware and software than is available right now in many schools. The direction of the project for the rest of this year and the coming year will probably be in terms of teacher generated monitors or inexpensively computer generated monitors.

Response coding. Another major consideration in the organization of data is the technique used for coding the responses of students in a form that can be analyzed. A large variety of techniques have been tried for this purpose and they are displayed in Table AR-2.10. Optical scanner or test scores are becoming increasingly available in schools. Their usefulness in reducing the burden of coding responses cannot be underestimated. The usefulness of types of machines for response coding by the project will be explored and written up.

Data storage and retrieval. Because the project is working with about 1500 school students in nine different courses across the country (TM-17) an efficient and versatile computer program was developed to edit, collate, and store all of the data collected about

Table AR-2.10 Organization of the Data: Monitor Generation and Response Coding

Monitor generation	Response Coding					
	Teacher	Teaching aid	Keypunch	Test scorer	Optical scanner	Computer terminal
Typed on masters	C	C	C	C	C	
Typed on 4x6 cards, then Xeroxed or masters (Gestofax or Thermofax Spirit)	C	C	C	C	C	
Computer printed: From cards or tape	C	C	C	C	C	
Computer printed: From algorithm	P	P	P	P	P	
Computer administered: By terminal from cards; Linear						P
Computer administered: By terminal from cards: Branched						P
Computer administered: By terminal from algorithm						P

Note.--C = operational and P = planned soon by Comprehensive Achievement Monitoring.

students and their responses to test questions. This program is described in detail in TM-7.

Analysis of the Data

Frequency of analysis. The frequency with which the analyses are performed is dependent very much on the types of decisions to be made. Decisions about student performance or instructional treatment must be made frequently, at least every monitoring period. Decisions about course improvement or experimental considerations can be made once or twice during the course. The frequencies of analysis are outlined in Table AR-2.11.

Type of analysis. A large range of analyses has been utilized to better understand school achievement of students. The model of school achievement suggests certain kinds of analyses. Others are important to teachers to analyze courses or to the achievement monitoring program in general. The analyses include information about individual student's performance. overtime, the performance of the class in general, performance of the student on specific objectives, the quality of individual items, the achievement of different objectives during the year, the reliability of questions and test scores, and the effects of certain attitudes towards the subject or the course in student's achievement The model itself suggests certain questions of the relevancy of different variables to school achievement for different subjects for instructional tasks and some of each kind have been utilized for one or more components of the comprehensive achievement monitoring, as detailed in TM-6, TM-10, TM-15, and TM-16.

Means of analysis. The teachers have been able to perform a variety of analyses of students, classes, objectives, and achievements by hand. For more complex analyses, the Stanford Computation Center has served to run programs written specifically for the project to analyze longitudinal comprehensive achievement monitoring data (TM-11, TM-12, TM-14), and the library computer programs have been used for certain kinds of analyses of learning models and experiments (TM-8, TM-16).

Table AR-2.11 Analysis of the Data: Frequency, Type, and Means of Analysis

Frequency of analysis	Type of analysis	Means of analysis		
		Teacher or staff	Project computer programs	Library computer programs
Monitoring period	Student	C	C	
	Class	C	C	
	Objective	C	C	
Course	Item		C	
	Achievement	C	C	
	Reliability		C	
	Attitude	C	C	
Experiment	Parameters		C	C
	Models	C		C
	Covariance			C

Note.--C = operational for Comprehensive Achievement Monitoring.

Report of the Analysis

Audience. The reports of the analyses are currently being distributed to the students and teachers of the course and being considered by the research staff of the project.

Means of reporting. Efficient, rapid, and comprehensive reporting is needed to complete the cycle of the evaluation. The finest data will have no impact on the educational program of a school if they are not readily available.

The report of the analysis is printed by the computer in a form which can be easily read by teachers, students, and the project staff. Each teacher receives a summary of the results for individual students in the course and the objectives of the course. The students receive individual reports about their own performances. A description of the output is available in Data Processing for Comprehensive Achievement Monitoring, TM-11, TM-12, and TM-14.

Teacher and Student Reaction

Teachers have continued to be interested and enthusiastic about the monitoring. They have continued into the second year of comprehensive achievement monitoring. The achievement profiles from the first year were used to modify and improve the course for the second year (TM-10; TM-16). The development of monitor items and the logistic problem have been the most serious obstacles to rapid implementation of comprehensive achievement monitoring.

Students have reacted favorably to the new style of achievement testing when they see the usefulness of the reports of their results. They quickly become accustomed to not being able to answer every question on the monitor. They react positively to the display of their progress.

Dissemination

Along with the formal means of dissemination listed below, several informal modes have communicated information about comprehensive achievement monitoring to a varied audience. Each of the teachers and principals affiliated with the project has written descriptions of it for and discussed it with visitors to his school.

Technical Memoranda

(See list on following page.)

Professional Meetings: Planned

American Educational Research Association

Symposium. Comprehensive Random Achievement Monitoring.
Organizer: William P. Gorth, Stanford University, Stanford Center for Research and Development
Chairman: David E. Evans, The University of Massachusetts
Improving Education Using Comprehensive Random Achievement Monitoring
Dwight W. Allen, The University of Massachusetts
William P. Gorth, Stanford University, Stanford Center for Research and Development
Instructional Objectives, Achievement Monitoring and Learning
William P. Gorth, Stanford University, Stanford Center for Research and Development
Mathematics Education Modified by Achievement Monitoring
Lee W. Popejoy, Poway District Schools
Instructional Management Systems Development Using CRAM
Paul D. Pinsky
Psychometric Issues in Comprehensive Random Achievement Monitoring
Richard H. Lindeman, Teachers College, Columbia University
Teacher Reeducation through CRAM
Donald H. DeLay, Davis-Macconnell-Ralston, Inc.
Discussants: Arno Bellack, Teachers College, Columbia University
Donald Rock, Educational Testing Service

Technical Memoranda

Number	Title	Author
AR-1	First Annual Report	Gorth
TM-2	Description of courses monitored by Project CRAM	Gorth & Popejoy
TM-3	Monitoring schedules developed for research by Project CRAM	Gorth, Stroud, & Knight
TM-4	The relation of repeated, comprehensive pretesting and students' achievement	Gorth, Allen, Popejoy, & Stroud
TM-5	A comparison of comprehensive versus unit pretesting and students' achievement	Gorth, Allen, Popejoy, & Stroud
TM-6	The evaluation of item performance in an item sampling case	Lindeman, Gorth, & Allen
TM-7	Computer-Based, instructional-testing data bank	Popejoy, Gorth, Grayson & Stroud
TM-8	Separate analyses of regression	Stroud & Gorth
TM-9	Educational innovations monitored by Project CRAM	Gorth
TM-10	Longitudinal comprehensive achievement monitoring in science education	Gorth & Allen
TM-11	A computer program to evaluate item performance by internal and external criteria in a longitudinal testing program using item sampling	Gorth, Grayson & Lindeman
TM-12	A computer program to tabulate performance profiles of longitudinal performance testing using item sampling	Gorth, Grayson, & Stroud
TM-13	The Project CRAM data bank for 1967-1968	Gorth
TM-14	A computer program to compose and print tests for instructional testing using item sampling	Gorth
TM-15	Investigating a linear model of learning in ninth grade algebra	Stroud & Gorth
TM-16	Analysis of the Project CRAM data for 1967-1968	Gorth & Pinsky
TM-17	Monitoring schedules developed for research; 1968-1969	Pinsky & Gorth
TM-18	Demographic, aptitude, & attitude surveys of the students, teachers, and schools in Project CRAM	Gorth & Pinsky
AR-2	Second Annual Report to the Charles F. Kettering Foundation	Allen & Gorth

These reports and further information may be obtained by contacting the Project CRAM staff or writing to William P. Gorth, Coordinator, Project CRAM, School of Education, Stanford University, Stanford, California, 94305

National Council on Measurement in Education

Paper. Item Analysis in an Item Sampling Case, by R. H. Lindeman, W. P. Gorth, and D. W. Allen.

National Science Teachers Association

Paper. Longitudinal Comprehensive Achievement Monitoring in Science Education: Course evaluation and individual diagnosis, by W. P. Gorth and D. W. Allen.

National Council of Teachers of Mathematics

Paper. Longitudinal Comprehensive Achievement Monitoring in Mathematics Education, by W. P. Gorth and D. W. Allen

Professional Journals: Planned

The relation of repeated, comprehensive pretesting and students' achievement, by Gorth, Allen, Popejoy, & Stroud.

A comparison of comprehensive versus unit pretesting and students' achievement, by Gorth, Allen, Popejoy, & Stroud.

The evaluation of item performance in an item sampling case, by Lindeman, Gorth, & Allen.

Computer-based, instructional-testing data bank, by Popejoy, Gorth, Grayson & Stroud.

Educational innovations monitored by Project CRAM, by Gorth.

Longitudinal comprehensive achievement monitoring in science education, by Gorth & Allen.

A computer program to evaluate item performance by internal and external criteria in a longitudinal testing program using item sampling, by Gorth, Grayson, & Lindeman.

A computer program to tabulate performance profiles of longitudinal performance testing using item sampling, by Gorth, Grayson, & Stroud.

A computer program to compose and print tests for instructional testing using item sampling, by Gorth.

Investigating a linear model of learning in ninth grade algebra, by Stroud & Gorth.

Priorities

(1) Develop revision of teacher-based comprehensive achievement monitoring.
(2) Incorporate comprehensive achievement monitoring into teacher education program.
(3) Increase objective and item banks.
(4) Reduce time needed to set up monitoring programs in courses.
(5) Tell many more people about comprehensive achievement monitoring.

References

(See the following two pages.)

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References

Alschuler, A. S. The achievement motivation development project: A summary and review. Cambridge, Mass.: Harvard University, 1967.

Association for Supervision and Curriculum Development. Evaluation as feedback and guide. Washington, D. C.: The Association, 1967.

Bloom, B. S. Taxonomy of educational objectives: cognitive domain. New York: David McKay, 1956.

Bloom, B. S., Hastings, J. T., & Madans, G. Formative and summative evaluation of student learning. New York: McGraw-Hill (forthcoming).

Carroll, J. B., & Spearritt, D. A study of a "model of school learning." Cambridge, Mass.: Harvard University, 1967.

Coleman, J. S., and others. Equality of educational opportunity. Washington, D. C.: U. S. Government Printing Office, 1966.

Cronbach, L. J. Evaluation for course improvement. Teachers College Record, 1963, 64, 672-683.

Cronbach, L. J. How can instruction be adapted to individual differences? In R. Gagné (Ed.), Learning and individual differences. Columbus, Ohio: Merrill Books, 1967.

Hambleton, R. K. The effects of item order and anxiety on test performance and stress. Paper presented at the annual meeting of the American Educational Research Association, Chicago, February, 1968.

Harman, H. H., Helm, C. E., & Loye, D. E. Computer assisted testing. Princeton: Educational Testing Service, 1968.

Husek, T. R., & Sirotnik, K. Item sampling in educational research. CSEIP Occasional Report #2. Los Angeles: University of California, 1967.

Lord, F. M., & Novick, M. R. Statistical theories of mental test scores. Menlo Park, Ca.: Addison-Wesley, 1968.

Mager, R. F. Preparing instructional objectives. Palo Alto, Ca.: Feron Publishers, 1962.

Metfessel, N. S., & Michael, W. B. A paradigm involving multiple criterion measures for the evaluation of the effectiveness of school programs. Educational and Psychological Measurement, 1967, 27, 931-936.

Rothkopf, E. Z. Some theoretical and experimental approaches to problems in written instruction. In J. D. Krumboltz (Ed.), Learning and the educational process. Chicago: Rand McNally, 1965.

Silberman, H. F. Design objectives of the instructional management system. Santa Monica, Ca.: System Development Corporation, 1968.

Spielberger, C. D. The effects of anxiety on complex learning and academic achievement. In C. D. Spielberger (Ed.), Anxiety and behavior. New York: Academic Press, 1966.

Stake, R. E. Learning parameters, aptitudes, and achievements. Psychometric Monographs No. 9. Richmond, Va.: Wilborn Byrd Press, 1961.

Stake, R. E. (Ed.) Perspectives of curriculum evaluation. Chicago: Rand McNally, 1967.

Stufflebeam, D. L. Toward a science of educational evaluation. Educational Technology, 1968, 8, 14, 5-12.

Tucker, L. R. Determination of generalized learning curves by factor analysis. Princeton: Educational Testing Service, 1960.

Yeager, J. L., & Lindvall, C. M. An exploratory investigation of selected measures of rate of learning. Journal of Experimental Education, 1967, 36, 78-81.

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Table TM-17.1a Summary of Achievement Monitoring Schedules, 1968 1969

Course	Class Size	Testing Frequency	Number of Forms	Number of Items Per Form	Pretest	Post-test
DH 110	150	Every 5 wks	10	20	No	No
DH 210	140	Every 4 wks	10	20	No	Planned
DH 321	140	Every 4 wks	9	15	No	Planned
DH 410	110	Every 4 wks	10	20	No	Planned
HS 420	130	Every week	14	9	Yes 18 item	Yes 36 item
JN 402	280	Every 2 wks	15	14	No	Planned
KA 240	130	Every 4 wks	12	24	Yes 36 item	Yes 36 item
KA 442	150	Every 2 wks	9	14	Yes 32 item	Yes 32 item
ML 205	150	Every 3 wks	10	30	Yes 30 item	Yes 30 item

Table TM-17.1b Summary of Achievement Monitoring Schedules, 1968-1969

Course	Arrangement of Items on the Forms	Scheduling Procedure	Repetition of Forms	Subject Matter and Grade	Method of Instruction
DH 110	Random	By Section	Spaced	English, 10th	II
DH 210	Random & Chronological	By Section	None	History, 10th	II
DH 321	Random & Chronological	By Section	None	Biology, 10th	II
DH 410	Random	By Section	Successive	Math, 10th	II
HS 420	Random & Chronological	By Grade Point Average	None	Math, 11th	Teacher Paced
JN 402	Position relates to content	By Teacher Judged Ability	Successive	Math, 9th	Modified II
KA 240	Random & Chronological	By Section	None	History, 11th	Teacher Paced
KA 442	Random & Chronological	By Grade Point Average	None	Math, 11th & 12th	Teacher Paced
ML 205	Random	By Section	Spaced	Math, 9th	II